

Formation of Fe/Mg Smectite under acidic conditions from synthetic Adirondack Basaltic Glass: An Analog to Fe/Mg Smectite Formation on Mars.

B. Sutter, T. Peretyazhko, R.V. Morris, D.W. Ming

Smectite has been detected as layered material hundreds of meters thick, in intracrater depositional fans, in plains sediments, and deposits at depth on Mars. If early Mars hosted a dense CO₂ atmosphere, then extensive carbonate should have formed in the neutral/alkaline conditions expected for smectite formation. However, large carbonate deposits on Mars have not been discovered. Instead of neutral to moderately alkaline conditions, early Mars may have experienced mildly acidic conditions that allowed for Fe/Mg smectite formation but prevented widespread carbonate formation. The objective of this work is to demonstrate that Fe(II)/Mg-saponite and nontronite can form in mildly acidic solutions (e.g., pH 4). Synthetic basaltic glass (< 53 µm) of Adirondack rock class composition was exposed to pH 4 (acetic acid buffer) and N₂ purged (anoxic) solutions amended with 0 and 10 mM Mg or Fe(II). Basaltic glass in these solutions was heated to 200°C in batch reactors for 1, 7, and 14 days. X-ray diffraction analysis of reacted materials detected the presence of phyllosilicates as indicated by a ~15.03-15.23 Å (001) peak. Smectite was confirmed as the phyllosilicate after treatments with glycerol and KCl and heating to 550°C. Trioctahedral saponite was confirmed by the presence of a 4.58 to 4.63 Å (02l) and 1.54 Å (060) peaks. Saponite concentration was highest, as indicated by XRD peak intensity, in the 10 mM Mg treatment followed by the 0 mM and then 10 mM Fe(II) treatments. This order of saponite concentration suggests that Fe(II) additions may have a role in slowing the kinetics of saponite formation relative to the other treatments. Nontronite synthesis was attempted by exposing Adirondack basaltic glass to pH 4 oxic solutions (without N₂ purge) at 200°C for 14 days. X-ray diffraction analysis indicated that mixtures of trioctahedral (saponite) and dioctahedral (nontronite) may have formed in these experiments based on the 02l and 060 peaks. Mössbauer analysis coupled with future experiments are planned to verify if nontronite can be formed under mildly acidic and oxic conditions. Results of this work demonstrate that acidic conditions could have occurred on an early Mars, which allowed for smectite formation but inhibited carbonate formation.